Introduction

Chapter Overview

Research and development (R&D) is widely recognized as being key to economic growth, along with factors such as "education, training, production engineering, design, and quality control" (Freeman and Soete 1999). Although R&D expenditures never have exceeded 3 percent of the U.S. economy and the precise effects of R&D have been difficult to measure (or sometimes even identify), scientific and government communities continue to study R&D expenditures to understand and improve the patterns of technological change that occur in the economy and society. As Rosenberg (1994) expressed:

> Science will often provide the capability to acquire information about technological alternatives that we do not presently possess, but *science does not make the acquisition of this information cost less.…*One valuable perspective on the cost of acquiring information is offered by the available data on R&D expenditures. These data are additionally valuable in showing the extent to which the generation and diffusion of knowledge has become an economic activity.

R&D decisionmaking—how much money different organizations spend and the areas of science or engineering on which they spend it—is critical to the future of the U.S. economy and national well-being. For this reason, the United States and many other nations collect extensive R&D expenditure data that are disseminated worldwide for study by analysts in a wide variety of fields.

In addition to indicating the direction of technological change, R&D expenditure data also measure the level of economic purchasing power that has been devoted to R&D projects compared with other economic activities. Industrial (private sector) funding of R&D, for example, may be considered an economic metric of how important R&D is to companies, since companies could easily devote those same funds to other business activities. Likewise, government support for R&D reflects governmental and societal commitment to scientific and engineering advancement, an objective that must compete for dollars against other functions served by discretionary government spending. The same basic notion is true for the other sectors that fund R&D: universities, colleges, and other nonprofit organizations.

Total R&D expenditures, therefore, reveal the perceived economic importance of R&D relative to all other economic activities. Because institutions invest in R&D without knowing the final outcome (if they did, then it would not be R&D), the amount they devote is based on their perception, rather than on their absolute knowledge, of R&D's value. Such information about R&D's perceived relative value is also extremely useful for economic decisionmaking. Of course, R&D data alone are not enough to accurately analyze the future growth of a field of study or an industrial sector, but they represent important input into such analyses. In addition to the total amount of R&D expenditures, a policy variable of equal importance is the composition of this R&D (Tassey 1999). Both econometric work and case studies have demonstrated the different but equally important roles of each phase of the R&D life cycle. Over this cycle, different classes of R&D funders and performers rise in importance, then give way to others. The availability and timeliness of these different participants determine the success or failure of technology-intensive industries relative to foreign competitors. This chapter is designed to provide a broad understanding of the nature of R&D expenditures and the implications of R&D expenditures for science and technology (S&T) policy.

Chapter Organization

This chapter is organized into five major parts that examine trends in R&D expenditures. The first and second parts look into R&D funded and performed solely in the United States. The first part contains information on economic measures of R&D spending in the United States and trends in financial support for R&D, giving particular attention to direct Federal R&D support as well as indirect fiscal measures to stimulate R&D growth. The second part describes trends in total R&D performance in the United States; areas addressed include industrial R&D performance and R&D performance by geographic location, character of work, and field of science.

The third part summarizes available information on R&D collaborations, alliances, and partnerships. It contains sections on intersector and intrasector R&D partnerships and alliances, including private-private, public-private, and public-public collaborations that have formed both domestically and internationally.

The fourth part compares R&D trends across nations. It contains sections on total and nondefense R&D spending, ratios of R&D to gross domestic product (GDP) among different nations, international R&D funding by performer and source (including information on industry subsectors and academic science and engineering fields), the character of R&D efforts (or R&D efforts separated into basic research, applied research, and development components), and international comparisons of government R&D priorities and tax policies.

The fifth part provides statistics on international R&D investment flows. It contains a review of the U.S. international R&D investment balance, discusses patterns in overseas and foreign R&D performed in the United States in terms of expenditures and facility placement, and offers a new Industry Globalization R&D (IGRD) index as a way of measuring which industries have adopted the most internationalized approach in their R&D activities.

R&D Support in the United States

Since 1994, R&D in the United States has risen sharply, from $169.2 billion to an estimated $264.6 billion in 2000.[1] In real terms (adjusting for inflation), this rise has been from $176.2 billion to $247.5 billion in constant 1996 dollars, reflecting an annual real growth rate of 5.8 percent. The increase of $71.3 billion 1996 dollars between 1994 and 2000 is the greatest single real increase for any six-year period in

[1]At the time this report was written, estimated data for 2000 were the latest figures available on R&D expenditures.

the history of the R&D data series, which began in 1953. (See figure 4-1.) The consistent pattern of R&D growth is noteworthy, implying a broad-based, increased interest in the promotion of R&D activities. See sidebar, "Definitions of Research and Development."

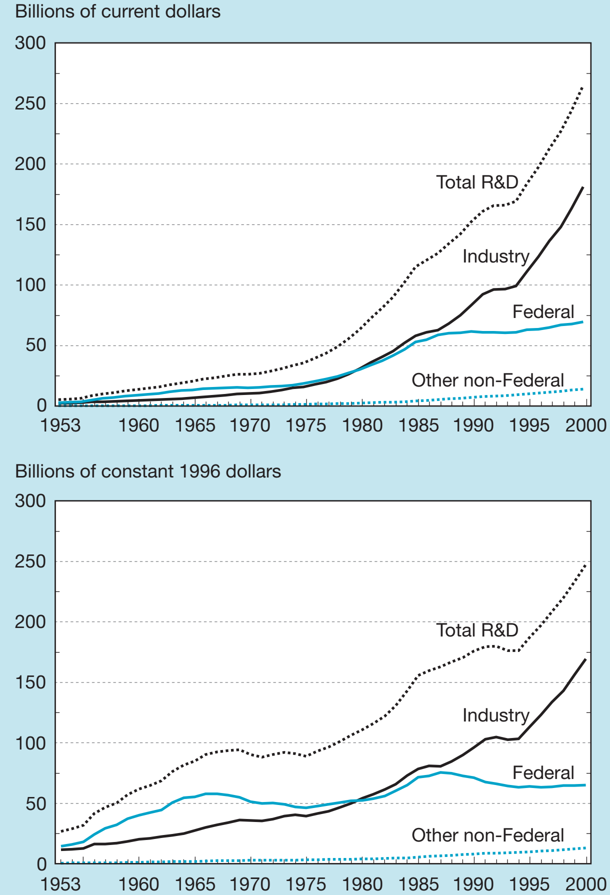
By comparison, gross domestic product (GDP), the main measure of the nation's total economic activity, grew in real terms by 4 percent per year between 1994 and 2000. Thus, R&D has generally been outpacing the growth of the overall economy since 1994. As a result, R&D as a proportion of GDP has risen from 2.40 percent in 1994 to 2.66 percent in 2000.

Organizations that conduct R&D often receive outside funding; conversely, organizations that fund R&D often do not perform all R&D themselves. Therefore, in any discussion of the nation's R&D, a distinction must be made between where the money came from originally (R&D expenditures characterized by source of funds) and where the R&D is actually being performed (R&D expenditures categorized by performer).

Private industry, which provided 68.4 percent ($181.0 billion) of total R&D funding in 2000, pays for most of the nation's R&D. Private industry itself used nearly all of these funds (98.1 percent) in performing its own R&D; most of the funds (70.9 percent) were used to develop products and services rather than to conduct research. In 2000, the Federal Government provided the second largest share of R&D funding, 26.3 percent ($69.6 billion), and the other sectors of the economy (i.e., state governments, universities and colleges, and nonprofit institutions) contributed the remaining 5.3 percent ($14.0 billion). (See figures 4-1, 4-2, and 4-3; and text table 4-1.)

Briefly, in terms of R&D performance—and discussed in greater detail below—industry in 2000 accounted for an even larger share of the total (74.6 percent), followed by universities and colleges (11.4 percent) and the Federal Government (7.2 percent). Federally Funded Research and Development Centers (FFRDCs), which are administered by various industrial, academic, and nonprofit institutions, accounted for an additional 3.5 percent, and other nonprofit organizations accounted for 3.3 percent. (See text table 4-1.)[2]

Figure 4-1.
National R&D funding, by source: 1953–2000



See appendix tables 4-5 and 4-6.

Science & Engineering Indicators – 2002

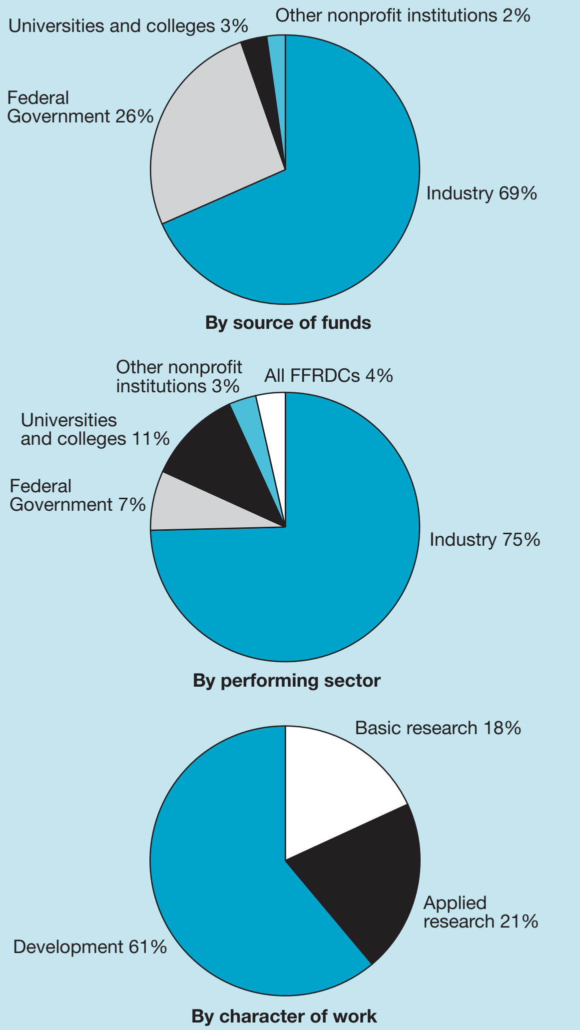
National R&D Growth Trends

Between 1953 and 1969, R&D expenditures grew substantially at a real annual rate of 8.2 percent. However, starting in 1969 and for nearly a decade thereafter, R&D growth failed to keep up with either inflation or general increases in economic output. In fact, between 1969 and 1975, real R&D expenditures declined by 0.9 percent per year, as both business and government tended to deemphasize research programs (See figure 4-1.) Federal funding, in particular, fell considerably during this period—down 2.9 percent in real terms, which was felt in both defense- and nondefense-related programs.

The situation turned around in the mid-1970s. Following an economic recovery from the 1974 oil embargo and the 1975 recession, R&D expenditures increased in real terms by approximately 74.8 percent from 1975 to 1985 (5.7 percent per year) compared with a 40.0 percent rise in real GDP over the same period. During the first half of this period (1975–80), there was considerable growth in Federal R&D funding for nondefense activities. Although defense-related R&D expenditures rose as well, much of the Federal R&D gain was attributable to energy-related R&D (particularly nuclear energy development) and to greater support for health-related R&D. Non-Federal R&D increases were concentrated in industry and resulted largely from greater emphasis on energy conservation and improved use of fossil fuels. Consequently, energy concerns fostered increases in R&D funding by both

[2]In some of the statistics provided in this chapter, FFRDCs are included as part of the sector that administers them. In particular, statistics on the industrial sector often include industry-administered FFRDCs as part of that sector because some of the statistics from the NSF Industry R&D Survey cannot be separated with regard to the FFRDC component. However, whenever a sector is mentioned in this chapter, the wording used will specify whether or not FFRDCs are included. FFRDCs are organizations exclusively or substantially financed by the Federal Government to meet particular requirements or to provide major facilities for research and associated training purposes. Each center is administered by an industrial firm, an individual university, a university consortia, or a nonprofit organization.

Figure 4-2.
Shares of national R&D expenditures: 2000



FFRDCs = Federally Funded Research and Development Centers

NOTE: Data labels rounded to nearest whole number. National R&D expenditures are an estimated $265 billion in 2000.

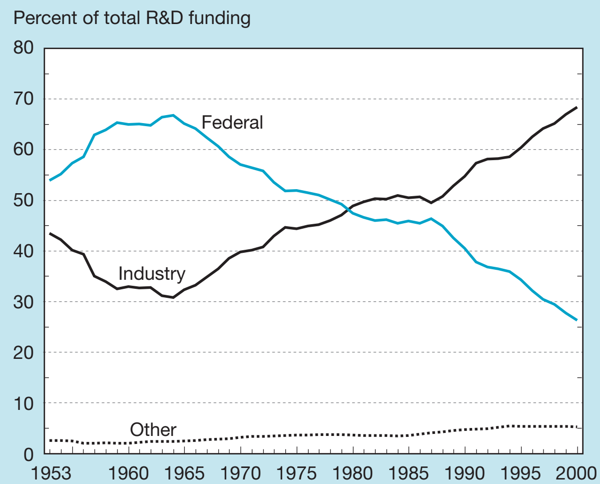
See appendix tables 4-3, 4-5, 4-7, 4-11, and 4-15.

Science & Engineering Indicators – 2002

Federal and non-Federal sources. Support for energy R&D rose more than 150 percent in real terms between 1974 and 1979 and accounted for approximately one-half of the national increase in real R&D spending.

Overall, the 1975–80 R&D recovery witnessed an average growth rate of 4.5 percent per year. That annual rate remained between 4 and 5 percent through 1982, although the early 1980s saw a heavy shift toward defense-related activities. As a result of these increases in defense R&D, growth in real R&D expenditures accelerated to an average annual rate of 8.5 percent over 1982–85. Such rapid growth had not been seen since the Sputnik era of the early 1960s.

Figure 4-3.
Shares of national R&D expenditures, by source of funds: 1953–2000



See appendix table 4-5. *Science & Engineering Indicators – 2002*

On average, R&D spending increased 7.0 percent per year in real terms in the first half of the 1980s, then again changed abruptly. In the nine years from 1985 to 1994, average annual R&D growth after inflation slowed to 1.4 percent, vis-à-vis a 2.8 percent annual real growth in GDP. Reductions in both Federal and non-Federal funding of R&D, as a proportion of GDP, had contributed to this slowing. However, it is primarily the decline in real Federal R&D funding that contributed to the slow growth of R&D in the early 1990s.[3]

This downward trend was reversed again in 1994, caused by substantial increases in industrial R&D, most notably in the computer and other information technology sectors.[4] As already indicated, R&D in the United States grew in real terms by 5.8 percent per year between 1994 and 2000, despite little real growth (0.5 percent per year) in Federal R&D support. During the same period, industrial support for R&D grew at a real annual rate of 8.6 percent. Much of this increase might be explained by the favorable economic conditions that generally existed during this period.

[3]These findings are based on performer-reported R&D levels. In recent years, increasing differences have been detected in data on federally financed R&D as reported by Federal funding agencies, on the one hand, and by performers of the work (most notably, industrial firms and universities), on the other hand. This divergence in R&D totals is discussed later in this chapter; see sidebar, "Tracking R&D: Gap Between Performer- and Source-Reported Expenditures."

[4]For a detailed discussion of this upturn, see Jankowski (1998).

Text table 4-1.
U.S. R&D expenditures, by performing sector, source of funds, and character of work: 2000
(Millions of dollars)

Performers	Total	Source of funds: Industry	Federal Government	U&Cs	Other nonprofit institutions	Percent distribution, by performer
Total R&D	264,622	181,040	69,627	8,166	5,789	100.0
Industry	197,280	177,645	19,635	NA	NA	74.6
Industry-administered FFRDCs	2,575	NA	2,575	NA	NA	1.0
Federal Government	19,143	NA	19,143	NA	NA	7.2
U&Cs	30,154	2,310	17,475	8,166	2,203	11.4
U&C-administered FFRDCs	5,801	NA	5,801	NA	NA	2.2
Other nonprofit institutions	8,750	1,085	4,079	NA	3,586	3.3
Nonprofit-administered FFRDCs	918	NA	918	NA	NA	0.3
Distribution by sources (%)	100.0	68.4	26.3	3.1	2.2	NA
Basic research, total	47,903	16,223	23,310	5,023	3,346	100.0
Industry	15,378	14,199	1,179	NA	NA	32.1
Industry-administered FFRDCs	704	NA	704	NA	NA	1.5
Federal Government	3,525	NA	3,525	NA	NA	7.4
U&Cs	20,656	1,421	12,857	5,023	1,355	43.1
U&C-administered FFRDCs	2,809	NA	2,809	NA	NA	5.9
Other nonprofit institutions	4,492	602	1,898	NA	1,991	9.4
Nonprofit-administered FFRDCs	339	NA	339	NA	NA	0.7
Distribution by sources (%)	100.0	33.9	48.7	10.5	7.0	NA
Applied research, total	55,041	36,400	14,460	2,577	1,604	100.0
Industry	37,648	35,396	2,252	NA	NA	68.4
Industry-administered FFRDCs	285	NA	285	NA	NA	0.5
Federal Government	5,826	NA	5,826	NA	NA	10.6
U&Cs	7,260	729	3,259	2,577	695	13.2
U&C-administered FFRDCs	1,401	NA	1,401	NA	NA	2.5
Other nonprofit institutions	2,504	275	1,320	NA	909	4.5
Nonprofit-administered FFRDCs	117	NA	117	NA	NA	0.2
Distribution by sources (%)	100.0	66.1	26.3	4.7	2.9	NA
Development, total	161,679	128,417	31,857	566	839	100.0
Industry	144,254	128,050	16,205	NA	NA	89.2
Industry-administered FFRDCs	1,586	NA	1,586	NA	NA	1.0
Federal Government	9,792	NA	9,792	NA	NA	6.1
U&Cs	2,238	160	1,360	566	153	1.4
U&C-administered FFRDCs	1,592	NA	1,592	NA	NA	1.0
Other nonprofit institutions	1,754	208	860	NA	686	1.1
Nonprofit-administered FFRDCs	463	NA	463	NA	NA	0.3
Percent distribution by sources (%)	100.0	79.4	19.7	0.3	0.5	NA

FFRDCs = Federally Funded Research and Development Centers; U&Cs = universities and colleges; NA = not applicable

NOTES: State and local government support to industry is included in industry support for industry performance. State and local government support to U&Cs ($2,197 million in total R&D) is included in U&C support for U&C performance.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *National Patterns of R&D Resources: 2000 Data Update,* NSF 01-309 (Arlington, VA, March 2001). Available at <http://www.nsf.gov/sbe/srs/nsf01309/start.htm>.

Science & Engineering Indicators – 2002

Trends in Federal R&D Support by National Objective, Federal Agency, and Performer Sector

Federal Support as a Share of the Nation's R&D Efforts

In recent years, the Federal Government has contributed smaller shares of the nation's R&D funding. The Federal Government had once been the main provider of the nation's R&D funds, accounting for 53.9 percent in 1953 and as much as 66.8 percent in 1964. Its share of R&D funding first fell below 50 percent in 1979 and remained between 44 and 47 percent from 1980 to 1988. Since then, its share has fallen steadily to 26.3 percent in 2000, the lowest ever recorded in the history of the NSF's R&D data series. This decline in the Federal Government share, however, should not be misinterpreted as a decline in the actual amount funded. Federal support in 2000 ($69.6 billion), for example, actually reflects a 0.8 percent increase in real terms over its 1999 level. Because industrial funding increased much faster (see

Definitions of Research and Development

The National Science Foundation (NSF) uses the following definitions in its research and development (R&D) surveys. They have been in place for several decades and generally are consistent with international definitions.

R&D. According to international guidelines for conducting R&D surveys, research and development, also called research and experimental development, comprises creative work that is undertaken on a systematic basis. R&D is performed for the purpose of "increasing the stock of knowledge, including knowledge about humanity, culture, and society," and using "this stock of knowledge to devise new applications" (Organisation for Economic Co-operation and Development (OECD) 1994).

Basic research. The objective of basic research is to gain more comprehensive knowledge or understanding of the subject under study without specific applications in mind. In industry, basic research is defined as research that advances scientific knowledge but does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest.

Applied research. Applied research is aimed at gaining the knowledge or understanding to meet a specific, recognized need. In industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes, or services.

Development. Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

R&D plant. R&D plant includes the acquisition of, construction of, major repairs to, or alterations in structures, works, equipment, facilities, or land for use in R&D activities.

Budget authority. Budget authority is the authority provided by Federal law to incur financial obligations that will result in outlays.

Obligations. Federal obligations represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when funds were appropriated or payment required.

Outlays. Federal outlays represent the amounts for checks issued and cash payments made during a given period, regardless of when funds were appropriated or obligated.

above), Federal support as a proportion of the total has continued to decline.

Federal R&D funding, in absolute terms, expanded between 1980 and 2000, from $30.0 to $69.6 billion, which, after inflation, amounted to a small, real growth rate of 1.1 percent per year. This rate, however, was not uniform across the period. From 1980 to 1985, Federal R&D funding grew on average by 6.3 percent in real terms annually. Nearly all of the rise in Federal R&D funding during the early 1980s was due to large increases in defense spending.

Federal support slowed considerably beginning in 1986, reflecting the budgetary constraints imposed on all government programs, including those mandated by the Balanced Budget and Emergency Deficit Control Act of 1985 (also known as the Gramm-Rudman-Hollings Act) and subsequent legislation (notably the Budget Enforcement Act of 1990, which legislated that new spending increases be offset with specific spending cuts). Between 1988 and 1994, Federal R&D support per year declined in real terms from $75.0 billion to $63.3 billion in constant 1996 dollars, but by 2000 had increased slightly to $65.1 billion. From 1996 to 2000, however, the direction of Federal R&D had shifted; for example, Federal support to academia, as a percentage of total Federal support, had risen from 22.2 to 25.1 percent.

Federal Support by National Objective

Defense- and Space-Related R&D. Defense-related R&D, as a proportion of the nation's total R&D, has shifted substantially. From 1953 to 1959, it rose from 48.0 to 54.3 percent; it then declined to a relative low of 24.3 percent in 1980. From 1980 to 1987, it climbed to 31.8 percent. It has fallen substantially since then, reaching a low of 13.6 percent in 2000. (See figure 4-4.)[5]

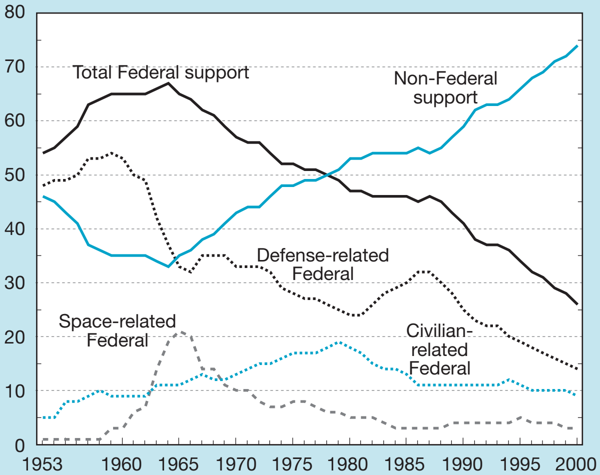
Space-related R&D funding, as a percentage of total R&D funding, reached a peak of 20.9 percent in 1965, during the height of the nation's efforts to exceed the Soviet Union in space travel. It then declined to a low of 3.0 percent in 1986. By 1995, it climbed back up to 4.5 percent, before, once again, slipping to 3.3 percent in 2000. Federal support for civilian-related (that is, nondefense-nonspace) R&D programs, as a percentage of total U.S. R&D, has been declining steadily since 1994, when it was 11.6 percent. It was 9.4 percent in 2000, the lowest since 1962 (when it had been 9.1 percent).

In 1980, the Federal budget authority for defense-related R&D was roughly equal to that for nondefense R&D.[6] (See insert in figure 4-5.) As a result of modifications to U.S. security measures in an evolving international arena, a defense-related R&D expansion occurred in the early and mid-1980s. For example, defense activities of the Department of Defense (DOD) and the Department of Energy (DOE) accounted for approximately one-half of the total Federal R&D budget au-

[5]These shares by national objective represent a distribution of performer-reported R&D data. They are distinct from the budget authority shares reported below that are based on the various functional categories constituting the Federal budget.

[6]R&D budget authority data represent a distribution of Federal source-reported data. See footnote 5.

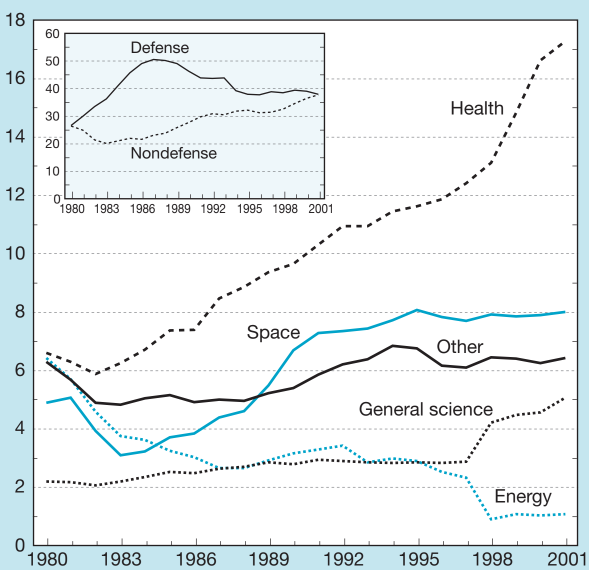
Figure 4-4.
Trends in Federal and non-Federal R&D expenditures as percentage of total R&D: 1953–2000



See appendix table 4-19. *Science & Engineering Indicators – 2002*

thority in 1980. By 1986, such defense-related activities peaked at 69 percent of the Federal R&D budget authority. (See figure 4-5.) This defense-related R&D expansion was followed by a period of defense-related R&D reductions in the late 1980s and the 1990s. Nondefense R&D, on the other hand, has been increasing steadily since 1983. For fiscal year (FY) 2001, the preliminary budget authority for defense R&D and for nondefense R&D are about equal ($41.4 and $41.3 billion, respectively) and are 42.2 and 43.3 percent higher in real terms than their respective 1980 levels.

Figure 4-5.
Federal R&D funding, by budget function: FYs 1980–2001



NOTES: "Other" includes all nondefense functions not separately graphed, such as agriculture and transportation. The 1998 increase in general science and decrease in energy resulted from a reclassification.

See appendix table 4-26. *Science & Engineering Indicators – 2002*

Of all the money authorized to be spent by the Federal Government on defense activities in 2001, according to the Federal budget authority, R&D (most of which is development) accounts for 14 percent. In contrast, R&D accounts for about 3 percent of the Federal nondefense budget authority, although many nondefense functions have much higher proportions. (See text table 4-2.) The budget allocation for defense programs declined by an average real annual rate of 1.7 percent from FY 1986 to FY 2001.

Civilian-Related R&D. Since 1986, the Federal budget authority for civilian-related R&D grew faster than that for defense-related R&D. In particular, the budget allocation for health- and space-related R&D increased substantially between FY 1986 and FY 2001, with average real annual growth rates of 5.8 and 5.0 percent, respectively. (As indicated in figure 4-5, most of this growth in the budget authority for space-related R&D occurred between FY 1986 and FY 1991.)

With regard to nondefense objectives (or "budget functions"), R&D accounts for 71.6 percent of funds for general science of which 80.7 percent is devoted to basic research. (See text table 4-2.) R&D accounts for only 7.4 percent of funds for natural resources and the environment, nearly all of which (91.7 percent) is devoted to applied R&D. Among funds for health, R&D represents 11.1 percent, most of which (55.1 percent) is devoted to basic research and nearly all of which is directed toward National Institutes of Health (NIH) programs.

At first glance, the R&D budget authority for energy appears to have declined rapidly in recent years, notably, from $2.3 billion in FY 1997 to only $0.9 billion in FY 1998 in constant 1996 dollars (as shown in figure 4-5). However, this effect was not an actual decline in economic resources devoted to energy R&D but merely the result of reclassification. Beginning in FY 1998, several DOE programs were reclassified from "energy" to "general science," so that the drop in energy R&D was equally offset by a rise in general science from $2.9 to $4.2 billion in constant 1996 dollars. (See also sidebar, "The Federal Science and Technology Budget and Related Concepts.")

Understanding the Growth in Federal Health-Related R&D. As illustrated in figure 4-5, the budget allocation for health-related R&D increased dramatically between FY 1982 and FY 2001, with an average real annual growth rate of 5.8 percent. As a result, health-related R&D rose from representing roughly one-quarter (27.5 percent) of the Federal, nondefense R&D budget allocation in FY 1982 to nearly one-half (45.6 percent) by FY 2001. Many individuals in the science community have expressed the concern that health-related R&D has received the lion's share of increases in Federal support for R&D, whereas the other broad areas (e.g., space, general science, energy, and the environment) have experienced much lower growth, or even declines, in Federal support.

Text table 4-2.
Budget authority for R&D by function and character of work: proposed levels for FY 2001
(Millions of dollars)

Budget function	Basic research	Applied research and development	R&D total	R&D as percentage of total budget
Total	20,259	62,472	82,730	7.7
National defense	1,262	40,152	41,414	13.6
Health	10,399	8,459	18,858	11.1
Space research and technology	1,761	6,971	8,732	66.7
General science	5,272	257	5,529	71.6
Natural resources and environment	162	1,771	1,932	7.4
Transportation	202	1,462	1,665	2.8
Agriculture	702	748	1,450	6.4
Energy	46	1,138	1,184	NA
All other	453	1,515	1,967	NA

NA = not applicable

NOTE: Total budget authority used in the percentage calculation (last column) includes only those functions in which R&D is conducted.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *Federal R&D Funding by Budget Function: Fiscal Years 1999–2001*, NSF 01-316 (Arlington, VA, 2001).

Science & Engineering Indicators – 2002

Although there is no consensus as to why health-related research has continued to receive increased Federal support, the current framework under which the Federal Government provides support for health and medical research can be traced back to important position statements made in the aftermath of World War II. These positions were expressed in two important reports: a 1947 report by J. Steelman entitled “Science and Public Policy” and a 1945 report by V. Bush entitled “Science—The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research.” These reports promoted support for other fields of science, but their specific focus on the topic of health research has supported the argument for growth in its Federal support since. In the early 1970s, medical research was promoted by the nation’s war on cancer, and in the 1980s it was promoted by the nation’s (and the world’s) concern over the acquired immune deficiency syndrome (AIDS) epidemic (Jankowski 2001a). Growth in health-related R&D in the 1990s has supported research on cancer and AIDS as well, but a great deal of the new funding has been directed toward other disease areas. Part of the reason for the observed growth of health-related R&D stems from opportunities afforded by biotechnology research advances, but perhaps part of the growth comes also from the influence of disease-specific lobbying groups.

R&D by Federal Agency

According to preliminary data provided by Federal agencies, DOD will obligate the most funds among Federal agencies for R&D support in FY 2001, $36.4 billion (44.6 percent) of all Federal R&D obligations. (See text table 4-3.) The bulk of these funds ($32 billion) will be for development as compared with basic or applied research. The agency obligating the second largest amount in R&D support is the Department of Health and Human Services (HHS) with $19.2 billion, most of which ($10.4 billion) will be for basic research, followed by the National Aeronautics and Space Administration (NASA) with $9.6 billion (most of which will be for development), DOE with $6.8 billion (nearly equally divided among basic research, applied research, and development), and NSF with $3.2 billion (almost all of which will be for basic research). Together, these five agencies account for 92.2 percent of all estimated Federal support for R&D in 2001: 93.1 percent of Federal support for basic research, 78.7 percent of Federal support for applied research, and 97.7 percent of Federal support for development.

The majority of HHS’s R&D support (57 percent) is directed toward academia. By preliminary estimates, HHS accounted for 61.9 percent of all Federal R&D obligations to universities and colleges, excluding university-administered FFRDCs in FY 2001. (See text table 4-4.) A total of 23.6 percent is spent internally, mostly in NIH laboratories. HHS also accounts for 71.6 percent of all Federal R&D obligations for nonprofit organizations in FY 2001. Approximately 6 percent of HHS R&D obligations are slated for industrial firms.

NSF and DOD are the other leading supporters of R&D conducted in academic facilities. (See text table 4-4.) Universities and colleges account for 82.8 percent of NSF’s R&D budget. The bulk of the remaining NSF budget is divided between university-administered FFRDCs (6.1 percent), other nonprofit organizations (5.8 percent), and industry (3.6 percent). In FY 2001, DOD provides only 4.2 percent of its R&D support to universities and colleges, in contrast to 69.5 percent to industry and 23.6 percent to Federal intramural activities. By comparison, DOE provides 10.4 percent of its support to universities, 16.8 percent to industry, 12.8 percent to Fed-

The Federal Science and Technology Budget and Related Concepts

In recent years, alternative concepts have been used to isolate and describe fractions of Federal support that could be associated with scientific achievement and technological progress. In a 1995 report (National Academy of Sciences 1995), members of a National Academy of Sciences (NAS) committee proposed an alternative method of measuring the Federal Government's science and technology (S&T) investment. According to the committee members, this approach, titled the Federal Science and Technology (FS&T) budget, might provide a better way to track and evaluate trends in public investment in R&D. The FS&T concept differed from Federal funds for research in that it did not include major systems development supported by the Department of Defense and the Department of Energy, and it contained not only research but also some development and some R&D plant.

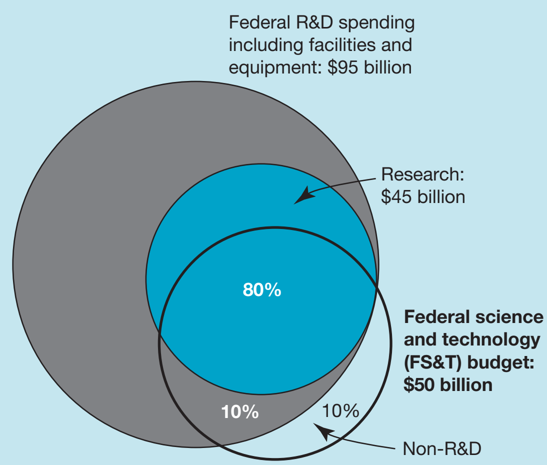
In the fiscal year (FY) 1999 budget, an alternative concept, the "Research Fund for America" (RFA), was introduced, which reflected an interest in addressing the FS&T concept previously proposed by NAS. Unlike the FS&T budget, however, which was constructed from components of the R&D budget, the RFA was constructed of easily tracked programs and included some non-R&D programs, such as National Science Foundation (NSF) education programs and staff salaries at the National Institutes of Health and NSF. The RFA consisted of only civilian (nondefense) R&D; it captured 94 percent of civilian basic research, 72 percent of civilian applied research, and 51 percent of civilian development. The FY 2000 budget referred to the concept "21st Century Research Fund," which was a slight modification of the RFA.

In the 2002 Budget of the United States, the 21st Century Research Fund is no longer mentioned, and the concept of the FS&T budget is readdressed. The new FS&T budget is approximately one-half of total Federal spending on R&D because it excludes funding for defense development, testing, and evaluation. It includes nearly all of the budgeted Federal support for basic research in FY 2002, more than 80 percent of federally supported applied research, and approximately 50 percent of federally supported nondefense development (U.S. Office of Management and Budget (OMB) 2001c).

As shown in figure 4-6, Federal R&D in the 2002 budget proposal, which includes expenditures on facilities and equipment, would reach a level of $95 billion. Of this amount, $45 billion would be devoted to basic and applied research alone. The FS&T budget would reach $50 billion and would include most of the research budget. However, differences in the definition of research and FS&T imply that not all research would be included in FS&T and vice versa. Moreover, a small proportion (10 percent) of FS&T funds would fall outside the category of Federal R&D spending.

Hence, the current FS&T budget developed by OMB largely includes the same programs that constitute the ongoing NAS FS&T categorization effort, a development that should ease analyses of these budgetary issues.

Figure 4-6.
Comparison of funding concepts in the FY 2002 budget proposal



NOTE: Percentages represent shares of the FS&T budget.

SOURCE: U.S. Office of Management and Budget, *Budget of United States Government: FY 2002* (Washington, DC, 2001).

Science & Engineering Indicators – 2002

eral intramural activities, and 35.3 percent to FFRDCs administered by universities and colleges.

Of all Federal obligations of R&D funds to FFRDCs in FY 2001, DOE accounted for 61.3 percent, NASA for another 19.8 percent, and DOD for 11.5 percent. More than one-half (59.1 percent) of DOE's R&D support is directed toward FFRDCs.

Unlike the other Federal agencies just mentioned, the U.S. Department of Agriculture (USDA), Department of Commerce (DOC), and Department of the Interior (DOI) spend most of their R&D obligations internally. Most of the R&D supported by these agencies is mission-oriented and conducted in their own laboratories, which are run, respectively, by the Agricultural Research Service, the National Institute for Standards and Technology (NIST), and the U.S. Geological Survey.

In contrast to total R&D obligations, which are devoted primarily to extramural R&D activities, only three agencies had intramural R&D expenditures that exceeded $1 billion in 2001 (which includes the costs associated with planning and administering extramural R&D programs): DOD, HHS (which includes NIH), and NASA. Together, these three agencies account for 76.2 percent of Federal intramural R&D.

Text table 4-3.
Federal R&D obligations, total and intramural by U.S. agency: FY 2001

Agency	Total R&D obligations (millions of dollars)	Total R&D obligations as share of Federal total (percent)	Intramural R&D[a] (millions of dollars)	Percentage of intramural R&D obligations	Percent change in real intramural R&D from previous year[b]
Federal Government total	81,526.2	100.0	19,352.4	23.7	–0.6
Department of Defense	36,396.6	44.6	8,578.8	23.6	–7.5
Department of Health and Human Services	19,234.6	23.6	3,678.1	19.1	3.7
National Aeronautics and Space Administration	9,602.4	11.8	2,496.9	26.0	5.5
Department of Energy	6,793.5	8.3	871.0	12.8	10.4
National Science Foundation	3,179.9	3.9	27.1	0.9	17.4
Department of Agriculture	1,779.3	2.2	1,250.5	70.3	8.0
Department of Commerce	1,127.0	1.4	775.8	68.8	0.9
Department of Transportation	866.1	1.1	289.3	33.4	36.4
Department of the Interior	619.4	0.8	545.9	88.1	8.0
Environmental Protection Agency	530.1	0.7	125.1	23.6	–3.3
Department of Veterans Affairs	367.0	0.5	367.0	100.0	–2.0
Department of Education	307.3	0.4	38.9	12.7	79.7
Agency for International Development	216.9	0.3	26.0	12.0	2.7
Smithsonian Institution	103.0	0.1	103.0	100.0	4.0
Department of Justice	102.8	0.1	44.7	43.5	10.6
Department of the Treasury	67.8	0.1	52.7	77.7	16.8
Department of Labor	66.0	0.1	22.3	33.8	9.8
Department of Housing and Urban Development	62.7	0.1	35.9	57.3	6.2
Nuclear Regulatory Commission	53.0	0.1	14.9	28.1	–35.7
Social Security Administration	41.6	0.1	1.2	2.9	–53.0
Federal Communications Commission	3.5	0.0	3.5	100.0	–12.1
Library of Congress	2.1	0.0	1.6	76.2	11.9
Department of State	1.5	0.0	0.5	33.3	–2.1
Federal Trade Commission	1.4	0.0	1.4	100.0	14.3
Appalachian Regional Commission	0.8	0.0	0.0	0.0	0.0
National Archives and Records Administration	0.1	0.0	0.1	0.0	0.0

[a]Intramural activities include actual intramural R&D performance and the costs associated with the planning and administration of both intramural and extramural programs by Federal personnel.

[b]Based on fiscal year GDP implicit price deflators. (See appendix table 4-1.)

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *Federal Funds for Research and Development: Fiscal Years 1999, 2000, and 2001,* NSF 01-328 (Arlington, VA, June 2001).

Science & Engineering Indicators – 2002

Federal Support to Academia

The Federal Government has long provided the largest share of R&D funds used by universities and colleges. In the early 1980s, Federal funds accounted for roughly two-thirds of the academic total. By 1991, however, that share had dropped to 58.6 percent, and it has since remained between 58 and 60 percent. Although this share of funding has not changed much in recent years, the actual amount of funding, in real terms, has grown on average by 5.1 percent per year between 1985 and 1994 and by 3.2 percent between 1994 and 2000. For more information on academic R&D, see chapter 5.[7]

Federal Funding to Industry

The greatest fluctuation in Federal support has been in Federal funds to industry (excluding industry-administered FFRDCs), which rose from a low of $7.4 billion in constant 1996 dollars in 1953 (when the NSF time series began) to a relative maximum of $32.6 billion in 1966.[8] (See figure 4-7.) It then declined to a relative minimum of $19.7 billion (constant 1996 dollars) in 1975; rose sharply to $37.1 billion by 1987; and fell sharply again to $21.1 billion by 1994. From 1994 to 2000, Federal support to industry has been relatively unchanged, ranging from $18.4 to $21.1 billion in constant 1996 dollars. Most recently, between 1999 and 2000, there was a 4.6 percent decline, in real terms, in Federal funds for industrial R&D activities. Overall, the Federal share of industry's performance has been steadily declining since its peak of 56.7 percent reached in 1959. Much of that decline can be attributed to declines in Federal funding to industry for defense-related R&D activities.

[7]Related topics in this chapter include "Industry-University Collaboration" in the section "Research Alliances: Trends in Industry, Government, and University Collaboration" and "Higher Education Sector" under "International Comparisons of National R&D Trends".

[8]The 1953 value is actually an overestimate because the 1953 and 1954 figures for Federal support to industry include support to industry-administered FFRDCs; the figures for subsequent years do not.

Text table 4-4.
Estimated Federal R&D obligations, by performing sector and agency funding source: FY 2001

Character of work and performer	Total obligations ($ millions)	Primary funding source		Secondary funding source	
		Agency	Percent	Agency	Percent
Total R&D	81,526	DOD	45	HHS	24
Federal intramural laboratories	19,352	DOD	44	HHS	19
Industrial firms	33,026	DOD	77	NASA	14
Industry-administered FFRDCs	1,386	DOE	77	HHS	13
Universities and colleges	17,724	HHS	62	NSF	15
Universities and college FFRDCs	4,189	DOE	57	NASA	31
Other nonprofit organizations	4,176	HHS	72	NASA	9
Nonprofit-administered FFRDCs	978	DOE	56	DOD	40
Basic research, total	20,274	HHS	51	NSF	15
Federal intramural laboratories	3,650	HHS	46	USDA	17
Industrial firms	1,193	HHS	37	NASA	33
Industry-administered FFRDCs	325	DOE	67	HHS	33
Universities and colleges	10,906	HHS	59	NSF	23
Universities and college FFRDCs	1,747	DOE	65	NASA	22
Other nonprofit organizations	1,980	HHS	83	NSF	9
Nonprofit-administered FFRDCs	340	DOE	91	DOD	5
Applied research, total	18,414	HHS	33	DOD	17
Federal intramural laboratories	6,142	HHS	25	DOD	18
Industrial firms	3,925	DOD	37	NASA	36
Industry-administered FFRDCs	586	DOE	83	HHS	10
Universities and colleges	4,790	HHS	66	DOD	10
Universities and college FFRDCs	1,201	DOE	68	NASA	24
Other nonprofit organizations	1,360	HHS	68	NASA	8
Nonprofit-administered FFRDCs	130	DOE	72	DOD	10
Development, total	42,838	DOD	75	NASA	11
Federal intramural laboratories	9,560	DOD	74	NASA	13
Industrial firms	27,908	DOD	85	NASA	10
Industry-administered FFRDCs	474	DOE	77	DOD	18
Universities and colleges	2,027	HHS	68	DOD	21
Universities and college FFRDCs	1,241	NASA	49	DOE	36
Other nonprofit organizations	835	HHS	49	NASA	23
Nonprofit-administered FFRDCs	508	DOD	70	DOE	28

FFRDCs = Federally Funded Research and Development Centers; DOD = Department of Defense; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; DOE = Department of Energy; NSF = National Science Foundation, USDA = Department of Agriculture.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *Federal Funds for Research and Development: Fiscal Years 1999, 2000, and 2001,* NSF 01-328 (Arlington, VA, June 2001).

Science & Engineering Indicators – 2002

Federal R&D financing for specific industrial sectors (including the industry FFRDCs that belong to those sectors) has varied markedly across time and across different industries. The Federal Government provided $22.5 billion for industry R&D in 1999, the most recent year for which detailed data by industrial category are available. Aerospace companies (or the industrial sector "aircraft and missiles") received 40.5 percent of Federal R&D funds provided to all industries. Consequently, 63.2 percent of the aerospace industry's R&D dollars came from Federal sources; the remaining 36.8 percent came from those companies' own funds. In comparison, the drugs and medicines sector in 1999 financed 100 percent of its R&D from company funds; machinery, 93.4 percent; computer and electronic products, 83.3 percent; transportation equipment other than aircraft and missiles, 95.3 percent; information services, 96.8 percent; and professional, scientific, and technical services, 75.7 percent.[9] See sidebar, "National Science Board Study on Federal Research Resources: A Process for Setting Priorities."

[9] The 100 percent company funding for the drugs and medicines sector does not include the benefits this sector receives from R&D financed by NIH.

The Federal R&D Tax Credit

In addition to direct R&D funding and government-performed research, the Federal Government provides a research and experimentation (R&E) tax credit aimed at stimulating research investment. In particular, the credit reduces the costs of using internal funds to fund private R&D activities. This tax credit on incremental research expenditures has been in place in the United States since 1981, having been renewed 10 times because of its temporary status. Most recently, the R&E tax credit was reinstated in the Tax Relief Extension Act of 1999 through June 2004.[10] As of this writing, the FY 2002 budget of the Bush administration proposes to make the R&E credit permanent (U.S. OMB 2001a).

[10] Public Law 106-170, Title V, December 1999.

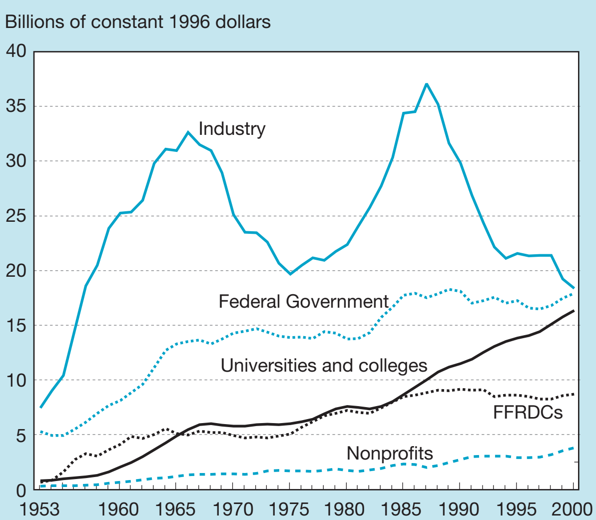
National Science Board Study on Federal Research Resources: A Process for Setting Priorities

The National Science Board (the Board) undertook an intensive two-year study on budget coordination and priority setting for government-funded research. The study included review of the literature on Federal budget coordination and priority setting for research, and invited presentations from and discussions with representatives of the Office of Management and Budget, the Office of Science and Technology Policy, the Federal R&D agencies, congressional staff, high-level science officials from foreign governments, experts on data and methodologies, and spokespersons from industry, the National Academies, research communities, science policy community, and academe. Discussions focused on research priority setting as it is practiced in government organizations, and possibilities for enhancing coordination and priority setting for the Federal research budget. After considering this information, the Board finds that:

- ♦ The appropriate focus for advice from the Board is the budget allocation processes for research within the White House and Congress that in the aggregate produce the Federal research portfolio.
- ♦ The allocation of funds to national research goals is ultimately a political process that should be informed by the best scientific advice and data available.
- ♦ A strengthened process for research allocation decisions is needed. Such allocations are based now primarily on faith in future payoffs justified by past success, but are difficult to defend against alternative claims on the budget that promise concrete, more easily measured results and are supported by large and vocal constituencies.
- ♦ The pluralistic framework for Federal research is a positive aspect of the system and increases possibilities for funding high-risk, high-payoff research. An improved process for budget coordination and priority setting should build on strengths of the current system and focus on those weaknesses that can be addressed by improved data and broad-based scientific input representing scientific communities and interests across all sectors.
- ♦ There is a need for regular evaluation of Federal investments as a portfolio for success in achieving Federal goals for research to identify areas of weakness in the national infrastructure for science and technology, and to identify a well-defined set of top priorities for major new research investments.
- ♦ Additional resources are needed to provide both Congress and the Executive branch with data, analyses, and expert advice to inform their decisions on budget allocations for research.

The full report, with NSB recommendations, can be accessed at: <http://www.nsf.gov/nsb/>.

Figure 4-7.
Federal R&D support, by performing sector: 1953–2000



FFRDCs = Federally Funded Research and Development Centers

See appendix table 4-6. *Science & Engineering Indicators – 2002*

The standard policy justification for a tax stimulus is that results from research, especially long-term research, often are hard to capture privately, as others might benefit directly or indirectly from it. Therefore, businesses might engage in levels of research below those that would benefit a broader constituency, such as a whole industry or the nation. In fact, many developed economies have in place some form of tax credit for research activity.[11]

Structure of the Credit and Tax Data

A regular credit is provided for 20 percent of qualified research above a base amount based on the ratio of research expenses to gross receipts for 1984–88. Younger companies follow different formulas. An alternative R&E credit is available for corporate fiscal years that began after June 30, 1996.[12] Both the regular and the alternative R&E credits include provi-

[11]For R&D tax policies abroad, see "Government Sector" under "International R&D by Performer, Source, and Character of Work" later in this chapter.

[12]The alternative credit is a lower rate that applies to all research expenses exceeding 1 percent of revenues or sales. The rates were raised by the 1999 Tax Relief Act to 2.65–3.75 percent. Companies may select only one of these two credit modes on a permanent basis, unless the Internal Revenue Service authorizes a change. The 1999 Act also extended the research credit to include R&D conducted in Puerto Rico and the U.S. possessions (U.S. OMB 2000).

sions for basic research payments paid to qualified universities or scientific research organizations above a certain base period amount. Qualified research covers "research undertaken to discover information, technological in nature, and useful in the development of a new or improved business component" (U.S. IRS 2000).[13] Because the focus is on domestic research performance, R&D conducted in the United States by foreign firms also is covered, whereas R&D conducted abroad by foreign affiliates of U.S. parent companies is not eligible.

The types of firms that claim the credit and their level of participation are affected by the provisions of the credit, including the definition of covered R&D and the spending base, offsetting credits or caps, and its temporary status. In addition, empirical studies of the effects of the tax credit also have to separate purely accounting effects, such as possible reclassification of activities or timing effects, from real changes in research spending. Thus, to assess precisely whether a particular tax incentive is inducing the kinds of research activities targeted by the credit is difficult at best. Nevertheless, Hall and Van Reenen (2000), based on a review of U.S. studies from the early 1980s to late 1990s, conclude that a dollar in tax credit likely stimulates a dollar of additional R&D. As an empirical generalization, however, this conclusion might not apply fully to certain segments of R&D performers, such as small companies or startup firms.

Total R&E credit claims and number of returns applying for the credit are available from Statistics of Income, Internal Revenue Service (IRS). In 1998 (the latest year for which these data are available), more than 9,800 returns claimed $5.208 billion in R&E credits, up 18.4 percent from 1997 dollar claims (U.S. IRS 2001).[14] The unusual doubling of the credit over 1996–97 followed a 12-month gap in the credit. (See text table 4-5). However, not all R&E claims are allowed because there is a limitation on the reduction of a company's total tax liability. Most claimants applied for the regular 20 percent credit. In 1998, total basic research credits were $398 million, or 7.6 percent of the total R&E credit, claimed by 551 returns.

Nearly three-fourths of R&E credit claims come from manufacturing corporations in any given year. An analysis by Whang (1998) using 1995 tax data identified pharmaceuticals, motor vehicles, aircraft, electronics, and computers as the industries with the largest claims. The author also reported that firms with at least $250 million in assets accounted for three-fourths of the dollar value of all credit claims for the same tax year. Another study, based on a 1998 survey sponsored by the Small Business Administration (SBA), found that only 71 of 194 (37 percent) small firms that responded to a question on the R&E tax credits reported claiming the credit (Cordes, Hertzfeld, and Vonortas 1999). Furthermore, only 28 of the survey firms claiming the tax credit reported that the credit stimulated additional R&D by an amount equal to or more than the amount of the credit. Of the small firms not claiming the credit, approximately one-half failed to exceed the statutory base for the credit, and about one-fourth considered the tax credit procedures too complicated to allow their participation.[15]

[13] The credit excludes research in the social sciences and humanities.

[14] Data for active corporations, other than forms 1120S, 1120-TEIT, and 1120-RIC.

Text table 4-5.
Research and experimentation tax credit claims

Year	Billions of current dollars	Number of tax returns
1990	1.547	8,699
1991	1.585	9,001
1992	1.515	7,750
1993	1.857	9,933
1994	2.423	9,150
1995	1.422	7,877
1996	2.134	9,709
1997	4.398	10,668
1998	5.208	9,849

SOURCE: U.S. Department of the Treasury, Internal Revenue Service, Statistics of Income, unpublished tabulations (Washington, DC, 2001).

Science & Engineering Indicators – 2002

Federal Budget Impact

In the language of the Federal budget, R&E credits fall in the category of tax expenditures—government revenue losses due to preferential provisions. According to the Treasury Department, the largest tax expenditures are those associated with the individual income tax. Tax expenditures from corporate income taxes relate mostly to cost recovery for certain investments, including research activities. The outlay-equivalent measure is one of three accounting methods used to estimate these tax expenditures.[16] This method translates R&E credits in terms comparable to Federal R&D outlays. This allows a comparison of the cost of the tax expenditure with that of a direct Federal outlay (U.S. OMB 2001a).

According to this measure, tax credit claims in 1998 were equivalent to outlays of $3.270 billion, or 4.6 percent of direct Federal R&D outlays in FY 1998 (See figure 4-8.) Although R&E claims data for tax year 2000 are not available, the credit generated an estimated outlay equivalent of $2.510 billion, or 3.4 percent of Federal R&D outlays in FY 2000. In constant 1996 dollars, the average outlay equivalent over 1981–2000 is $2.1 billion.

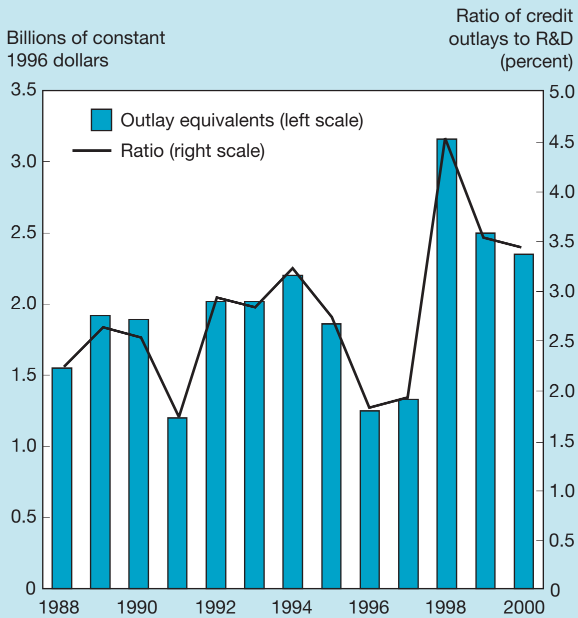
Historical Trends in Non-Federal Support

R&D financing from non-Federal sources grew by 5.9 percent per year after inflation between 1953 and 1980. Between 1980 and 1985, concurrent with gains in Federal R&D spending, it grew by an even faster rate of 7.6 percent per year in

[15] The study is based on a random sample of 1,053 small firms (fewer than 500 employees), of which 91 percent were privately owned; 198 small firms completed the survey. The average responding firm had a mean age of 23 years, 79 employees, and $5.7 million in annual sales.

[16] The other two measures are revenue loss and present value of tax expenditures. For a comparison of these methods, see U.S. OMB (2001a).

Figure 4-8.
Budgetary impact of Federal research and experimentation tax credit: FYs 1988–2000



NOTE: The ratio of credit outlays to R&D is the outlay equivalent cost of the tax credit divided by total Federal R&D outlays.

See appendix table 4-30. *Science & Engineering Indicators – 2002*

real terms. It then slowed to 4.4 percent between 1985 and 1990 and to 3.3 percent between 1990 and 1995 but rose to 8.2 percent over the 1995–2000 period.

As already discussed, most non-Federal R&D support is provided by industry. Of the 2000 non-Federal support total ($195 billion), 92.8 percent ($181 billion) was company funded. Industry's share of national R&D funding first surpassed that of the Federal Government in 1980, and it has remained higher ever since. From 1980 to 1985, industrial support for R&D, in real dollars, grew at an average annual rate of 7.7 percent. This growth was maintained through both the mild 1980 recession and the more severe 1982 recession. (See figure 4-1.) Key factors behind increases in industrial R&D included a growing concern with international competition, especially in high-technology industries; the increasing technological sophistication of products, processes, and services; and general growth in defense-related industries, such as electronics, aircraft, and missiles.

Between 1985 and 1994, growth in R&D funding from industry was slower, averaging only 3.1 percent per year in real terms. This slower growth in industrial R&D funding was only slightly greater than the real growth of the economy over the same period (in terms of real GDP), which was 2.8 percent. In contrast, from 1994 to 2000, non-Federal R&D support grew in real terms by 8.6 percent per year compared with 4.0 percent for the economy overall.

R&D funding from other non-Federal sectors, namely, academic and other nonprofit institutions and state and local governments, has been more consistent over time. It grew in real terms at average annual rates of 6.4 percent between 1980 and 1985, 8.5 percent between 1985 and 1990, 3.8 percent between 1990 and 1995, and 5.5 percent between 1995 and 2000. The level of $14.0 billion in funding in 2000 was 4.9 percent higher in real terms than its 1999 level of $13.0 billion. Most of these funds had been used for research performed within the academic sector.

R&D Performance in the United States

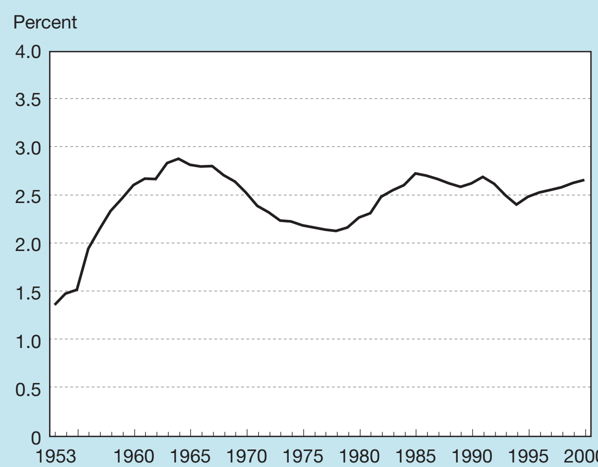
U.S. R&D/GDP Ratio

Growth in R&D expenditures should be examined in the context of the overall growth of the economy, because, as a part of the economy itself, R&D is influenced by many of the same factors. Furthermore, as mentioned earlier, the ratio of R&D expenditures to GDP may be interpreted as a measure of the nation's commitment to R&D relative to other endeavors.

A review of U.S. R&D expenditures as a percentage of GDP over time shows an initial low of 1.36 percent in 1953 (when the NSF data series began), rising to its highest peak of 2.88 percent in 1964, followed by a gradual decline to 2.12 percent in 1978. (See figure 4-9.) From that low in 1978, U.S. R&D expenditures again rose steadily to peak at 2.72 percent in 1985 and did not fall below 2.50 until 1993. In 1994, the rate dropped to 2.40, its lowest point since 1981. Starting in 1994, however, R&D/GDP has been on an upward trend as investments in R&D have outpaced growth of the general economy. As a result, the current ratio of 2.66 for 2000 is the highest the ratio has been since 1985.

The initial drop in the R&D/GDP ratio from its peak in 1964 largely reflects Federal cutbacks in defense and space R&D programs, although gains in energy R&D activities between 1975 and 1979 resulted in a relative stabilization of the ratio between

Figure 4-9.
Historical pattern of R&D as percentage of GDP: 1953–2000



See appendix tables 4-1 and 4-3.

Science & Engineering Indicators – 2002